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Indian Standard

GUIDANCE FOR ENVIRONMENTAL TESTING

PART VII SULPHUR DIOXIDE TEST FOR CONTACTS AND CONNECTIONS

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PART VII SULPHUR DIOXIDE TEST FOR CONTACTS AND CONNECTIONS

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GUIDANCE FOR ENVIRONMENTAL TESTING

PART VII SULPHUR DIOXIDE TEST FOR CONTACTS AND CONNECTIONS

0. FOREWORD

0.1 This Indian Standard (Part VII) was adopted by the Indian Standards Institution on 5 June 1980, after the draft finalized by the Environmental Testing Procedures Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard (Part VII) deals with guidance to sulphur dioxide test for contacts and connections of electronic and electrical items. The sulphur dioxide test is included in IS : 9000 (Part XXVI)-1980*.

0.3 In the preparation of this standard, assistance has been derived from Doc : 50B (Central Office) 217 'Draft—Guidance to Publication 68-2-42, Test Kc : Sulphur dioxide test for contacts and connections' issued by the International Electrotechnical Commission.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part VII) provides guidance to the test intended to provide accelerated means to assess the corrosive effects of atmosphere polluted with sulphur combustion products on contacts and connections.

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*Basic environmental testing procedures for electronic and electrical items : Part XXVI Sulphur dioxide test for contacts and connections.

†Rules for rounding off numerical values (*revised*).

2. OBJECT

2.1 This test is used to study the following:

a) The effect on contact resistance of precious metal* or precious metal coated contacts and connections by exposure to atmosphere polluted by sulphur dioxide; and

b) The effectiveness of crimp or wire wrap joints.

2.2 The test may be used in type approval of components or equipment from a supplier or as a comparison in the choice of materials, processes or designs. When used in acceptance testing the sulphur dioxide test is usually preceded by a suitable ageing test [for example, by a mechanical endurance test† to impart wear to the contact surface in case of **2.1** (a); or by heat cycling in case of **2.1** (b)]. The principal criterion of performance is the rise of contact resistance which may occur as a result of exposure to the sulphur dioxide atmosphere.

3. APPLICABILITY OF THE TEST

3.1 This test provides accelerated means of assessing the effects of sulphur dioxide containing atmosphere on contacts and connections. It is particularly useful as a comparative test. The relation between test values and service life is influenced by a large number of factors and can only be vaguely estimated after years of experience with this test in comparison with behaviour in the field. The test, therefore, cannot be expected to give a direct and exact determination of the actual service life of the tested contact or connection in any given natural atmosphere in practice. It is hardly necessary to state that the test is not suitable as a 'general corrosion test', that is to predict the corrosive behaviour of a given component in atmospheres, the major corrosive agent of which is none other than sulphur dioxide.

3.2 On the other hand, the test is very useful for checking the behaviour of production batches in comparison with the behaviour of analogous components. In the course of time other applications may be found for the test method.

4. INTRODUCTION TO THE TEST

4.1 Satisfactory performance during the desired lifetime of contacts and connections depends on many parameters, some of them determined by their design (type, materials, forces, etc) and others by the environment

*It should be noted that, for the purpose of this test, silver and some of its alloys are not considered to be precious metals, because the sulphur dioxide test would not yield useful results on contacts made of these materials or using them as intermediate layers, as they are not corroded by sulphur dioxide but very strongly by other pollutants such as hydrogen sulphide.

†As normally used in the mechanical endurance test, but for acceptance testing probably with a lower number of operations or a shorter ageing time than used for type testing.

in which they have to function. Concerning the effects of the environment, special attention shall be paid to the polluting substances contained — usually in very small amounts — in the atmosphere. IS : 9000 (Part XXVI)-1980* relates to one of the most important pollutants found especially in urban and industrial atmospheres, namely sulphur dioxide (SO_2).

5. SULPHUR DIOXIDE IN THE ATMOSPHERE

5.1 Atmospheric corrosion of metals is usually brought about by humidity and by pollution products in the atmosphere. One of the main sources of pollution is the combustion products of fossil fuels. Of these combustion products, the corrosive constituent present in the largest quantity is sulphur dioxide (SO_2); sulphur trioxide (SO_3), oxides of nitrogen and chlorine have also been detected but in much lower concentrations.

5.2 In a humid atmosphere, sulphur dioxide will corrode all except precious metals and silver and can have a pronounced effect on the performance of temporary contacts. In extreme cases, contacts can go open circuit as a result of corrosion products building up and preventing a metal to metal contact.

6. TYPES OF CONTACTS AND CONNECTIONS

6.1 Contacts and connections may be divided into two types and could be described as permanent or temporary. In both cases, metal surfaces are held together by an external force.

6.2 In the case of permanent connections, the force is very great and will usually cause permanent deformation of the metals and it is possible that a form of local welding takes place. Such connections are not intended to be made and broken during their lifetime. Examples of permanent connections are crimp and wrap joints.

6.3 With temporary connections, the force holding the metals in contact is by comparison light and they are of course designed to be made and broken possibly very many times during their lifetime. Examples of temporary connections are: connectors, switches and relays. In temporary connections the areas of metal which make contact with each other are in some cases referred to as contacts.

6.4 The contacts or contact areas in temporary connections will be made of various metals according to duty and application.

6.5 Most metals, with the exception of precious metals, suffer from atmospheric corrosion. When contact materials corrode, contact resistance

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*Basic environmental testing procedures for electronic and electrical items: Part XXVI Sulphur dioxide test for contacts and connections.

increases. The extensive use of precious metal contacts would be costly, so it is common in many applications to use precious metal alloys or coatings of precious metal or alloys over base metals for contact materials.

6.6 In the case of permanent joints, it is not normal to use precious metals and some general corrosion of external surfaces by sulphur dioxide shall be expected. But, in a properly designed and made crimp or wire wrap joint, corrosion does not occur between the contact surfaces due to the cold weld at high pressure. However, in joints that are poorly made or weakened, for example, as a result of thermal cycling, corrosive gas will penetrate into those contact areas with a resultant increase in contact resistance

7. PARAMETERS OF THE TEST

7.1 The major parameters of the test are the following:

7.1.1 *Concentration of Sulphur Dioxide* — From the many values proposed, a concentration of 25 ppm has been chosen after much experimentation and many years of trial. It is high enough to give a reasonable level of acceleration to the test and yet not so high that it will cause the corrosive mechanism to depart from that found in service.

Small amounts of sulphur trioxide have a much lower degree of importance.

It is important to ascertain that stable conditions of sulphur dioxide concentration reign in the test chamber. Periodic checks during the entire period are also necessary. Any established method for the determination of sulphur dioxide may be used provided that it has been proved able to measure the specified concentration with sufficient accuracy.

7.1.2 *Relative Humidity* — Little corrosion will occur below 70 percent RH (relative humidity) while at levels above 80 percent the morphology of the corrosion products may change considerably. At the chosen level of 75 percent the nature of the corrosion products is in most cases very similar to those formed naturally in the field.

It is important to ascertain that stable conditions of relative humidity (as well as the concentration of the corrosive agent) reign in the test chamber. Periodic checks during the entire test period are also necessary. Any of the known methods for determination of relative humidity may be used, provided that they can measure the specified tolerances with sufficient accuracy. Wet and dry bulb methods have been found satisfactory, provided the wet sock is changed frequently. Calibration of the measuring instrument should be carried out at the beginning and end of each test.

7.1.3 *Temperature* — At temperature above 30°C, there is again a tendency for the nature of the corrosion mechanism to change while at lower temperatures the test-time would unduly increase. The temperature of 25 ± 2°C is the most satisfactory compromise. Close control of temperature is necessary to enable the relative humidity to be held within the specified limits.

7.1.4 *Flow Rate* — A continuous flow of gas through the test cabinet is used so that the concentration of sulphur dioxide is maintained constant and is not depleted as the gas is taken up by the absorbing surfaces inside the test cabinet. A relative velocity within specified limits is required between the atmosphere and the test items and is obtained by moving the items or stirring the atmosphere in the test chamber. This is to avoid local depletion within the test chamber due to stationary air pockets. Reasonable care shall be taken to ensure that air flow can take place around test items in the cabinet, and also to ensure that the cabinet is not over-packed. All these precautions are necessary in order to ensure that all items are given uniform treatment throughout the test period.

7.1.5 *Test Duration* — The corrosion brought about by exposure to the test atmosphere and the degradation of the test contacts increase with the duration of the exposure, although the increase will generally not be proportional to the time of exposure. Nevertheless, different severities of the test can be obtained by lengthening the time of exposure, as set out in **8**.

8. SEVERITY OF THE TEST

8.1 It is, in principle, impossible to attach a unique acceleration factor to the test conditions. This is because the acceleration produced depends on the construction and materials present in the test items, and their conditions of use. Some general guidance based on experience to date is given here. This guidance should become more complete as experience with the test grows.

8.2 The following considerations apply when assessing the results of a test, or choosing the test duration appropriate to a particular case.

8.2.1 If a contact surface is not shielded or enclosed, and if it is exposed to a circulating atmosphere, then the corrosion rate is directly related to the concentration of the corroding agent.

8.2.2 The contacts inside most practical test items are normally partially enclosed or shielded by the structure of the component or sub-assembly. With such items, the rate of corrosion is then limited by the mass transport of the pollutant through the atmosphere to the contact (that is, the sulphur dioxide concentration adjacent to the contact surface is lower than that in the atmosphere surrounding the test item).

8.2.3 Consequently the acceleration produced by the test is likely to be lower for unshielded contacts and connections than for shielded or enclosed ones.

IS : 9000 (Part XXVI)-1980* suggests 4, 10 and 21 days as preferred severities of the test. Of these, a duration of 21 days is normal for acceptance testing of precious metal or precious metal coated contacts. The shorter durations of 4 and 10 days may be used for testing new designs and comparing different materials.

8.2.4 The duration to be chosen should be contained in the relevant specification or else be agreed upon by the interested parties.

9. METHODS OF GENERATING THE TEST ATMOSPHERE

9.1 IS : 9000 (Part XXVI)-1980* specifies the following two methods for the generation of the test atmosphere:

a) By mixing directly the necessary constituents (sulphur dioxide, water vapour and air) before introducing the mixture into the test cabinet. Particular care shall be taken to ensure that a homogeneous mixture is obtained. In view of the very small amount of sulphur dioxide which shall be mixed with a large volume of air, more than one mixing operation is likely to be required for a homogeneous mixture to be obtained.

b) By generating the sulphur dioxide by a burning process and adjusting the resulting gas mixture to the specified composition. Natural gas, propane or butane is used as the combustible gas and carbon disulphide as the source of sulphur (which on combustion yields sulphur dioxide). Close control of the temperature of the carbon disulphide reservoir and of the flow rate of the combustible gas is required.

9.1.1 In the light of present knowledge, both methods of generation may be considered equivalent for many metals and alloys and interchangeable for the purpose of this test. They yield dry crystalline corrosion products resembling those found in service. For some metals, for example, copper there can however be a significant difference in the quantity of corrosion products due to the effect of nitrogen dioxide (NO_2) present in the gas burning method (up to 2 ppm) and generally believed to be absent with the gas mixing method.

IS : 9000 (Part XXVI) - 1980* describes in appendices examples of apparatus suitable for the generation of the test atmosphere according to both methods.

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*Basic environmental testing procedures for electronic and electrical items : Part XXVI Sulphur dioxide test for contacts and connections.

10. EVALUATION OF RESULTS

10.1 The main criterion of performance in this test is change of contact resistance while visual appearance is of secondary importance. It shall be remembered that most metals and alloys except precious metals will corrode in this test and such corrosion shall be expected. Performance will be judged on the change in contact resistance.

10.2 When testing permanent connections of the crimp or wire wrap type, it is the change of resistance of the joint which is to be measured. If there is a significant increase in contact resistance, it is because the joint was not gas tight and it was a poor joint.

10.3 When testing temporary connections, the contacts may be exposed in the mated or unmated condition. Mated contacts shall be measured at the end of the exposure period without being disturbed while unmated contacts shall be mated once only and measured.

10.4 The method used for measuring the contact resistance will be stated in the relevant specification. As the contacts for which this test is primarily designed are those intended to carry small current low voltage signals, it is necessary to use a low voltage low current measurement method (maximum 20 mV, 50 mA) in order not to destory films of corrosion products which may have formed.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2